S282 Astronomy

Mapping the Milky Way

Study time: 45 minutes

Summary

This activity relates to a video sequence in which you will see how observations made at various wavelengths are used to by astronomers to gain insights into the structure of our Galaxy.

You can watch this video sequence at any time while studying Chapter 1 of *An Introduction to Galaxies and Cosmology*, but you may find it to be of more benefit during the second half of the chapter.

Learning outcomes

- Understand the structure of the Milky Way and how it has been discerned.
- Appreciate some of the key developments in our knowledge of the structure of the Milky Way.

The activity

This activity follows the historical development of our growing knowledge of the Milky Way, a mapping made all the more difficult because we are deeply embedded within the Milky Way, and see it from a single viewpoint.

- Start the S282 Multimedia guide and then click on Mapping the Milky Way under the 'Our Galaxy' folder in the left-hand panel.
- Press the Start button to run the video sequence.

After you have watched the video sequence, read the summary provided in the 'Notes' below.

Notes

You saw that in the 1920s the astronomer Edwin Hubble proved that many of the nebulae catalogued in the previous 150 years were huge assemblages of stars lying beyond our Galaxy – the Milky Way – rather than within it. Therefore, he had shown that the Milky Way is not the only galaxy, but that there are very many others. These other galaxies come in a variety of shapes and sizes, but which shape, if any, corresponds to the shape of our own Galaxy? Is it spiral, elliptical, irregular, or something else?

The development of radio astronomy was crucial in answering this question. This is because, at visible wavelengths, much of the Galaxy is obscured from view by interstellar dust. The importance of radio astronomy became apparent when the astronomer Hendrik van de Hulst predicted the existence of a spectral line that would be little attenuated by dust. This line is at the radio wavelength of 21 cm, and should be emitted by the interstellar atomic hydrogen that was thought to be present throughout the Galaxy. However, it was not until 1951 that developments in radiotelescopes gave sensitivities sufficient for the line to be detected.

Later studies of the 21 cm line, continuing today, have shown that the velocities of interstellar hydrogen clouds are too high to be explained by the gravitational field of the matter that can be seen in the form of stars and interstellar clouds. This is one indication that the Galaxy contains large quantities of dark matter, matter that so far is detectable only by its gravitational effect. This is an active area of enquiry, with largely unsolved problems regarding the nature and distribution of dark matter.

You then saw that infrared astronomy too has been of great importance in mapping the Milky Way, because, like radiowaves, infrared waves are little affected by dust. Infrared measurements are best made from above the Earth's atmosphere, and have revealed stars hidden by dust at visible wavelengths, and have improved our view right to the centre of the Galaxy.

A key feature of a map is its scale, and the distance scale in the Milky Way, for large distances, depends largely on using variable stars as standard candles. To calibrate the standard candle we need to measure the distance to some nearer ones by an independent method. In the 1990s this was achieved through parallax measurements made by the European Space Agency (ESA) satellite Hipparcos. The scale will be further refined when the ESA mission GAIA is launched – this would make parallax measurements far more accurate even than those made by Hipparcos.

Video credits

This video sequence has been re-edited by The Open University in 2003 from two existing BBC TV programmes produced for The Open University.

Speakers (in order of appearance)

Mike Merrifield (University of Nottingham; formerly the University of Southampton)

Adriaan Blaauw (New Leiden Observatory, and the Kapteyn Institute)

Hendrik van de Hulst (New Leiden Observatory)

Gerry Gilmore (Institute of Astronomy, University of Cambridge)

Jim Cohen (NRAL, University of Manchester)

Butler Burton (New Leiden Observatory)

Michael Hauser (NASA Goddard Space Flight Center)

Reinhard Genzel (Max-Planck-Institut für Extraterrestrische Physik)

Academic consultant – Sean Ryan (The Open University)